

Array-based Deep Space Network for NASA

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Abstract

The Array-based Deep Space Network (DSN Array) will be a part of more than 10^3 times increase in the downlink/telemetry capability for the deep space network (DSN) of NASA. The key function of the DSN Array is to provide cost effective, robust telemetry, tracking and command (TT&C) services to the space missions of NASA and its international partners.

Architecture - DSN array segment consists of ten elements. The DSN Array elements include receive array of 1200 12 m antennas, uplink array antennas, telemetry, tracking and command, frequency and timing signal, monitor and control, information technology infrastructure, support facilities and the array operations. Roughly one third of the assets will be located at or near each longitude of the existing NASA's deep space network (DSN) in western USA, Australia and Europe, to provide continuous coverage. A site at each longitude will occupy roughly 10-12 square kilometers including facilities. The downlink/uplink antennas will be connected to a regional array center (RAC) where most signal processing will be done. Each RAC, in turn, will be connected to a central place, DSN Array Central, from where all array activities will be controlled in real time.

Each downlink antenna will be able to simultaneously receive at 8.4 GHz (X-band) and 26-33 or 31-38 GHz (Ka-band) in both right and left circular polarizations, and will produce two IF signals of bandwidth up to 500 MHz. The IF signals will be transported to the RAC building where further signal processing will be done. The signal processing equipment will produce up to 16 phased array signals at each longitude. The phased array signals can be routed for extraction of telemetry and radiometric data or to special processing equipment. There will also be a correlation capability to measure auto and cross correlations between IF signals from individual downlink antennas.

Operation's Concept - The approach to the DSN Array support is based on using links and passes. A pass is continuous period of support for TT&C and a link is defined as logical aggregation of assets to provide support for a pass. The DSN Array will have automation necessary to operate the system with a few (about 5) 24X7 real time operators. It will have automatic schedule handling and resource allocation. The user supplied mission parameter file will be combined with resource allocations to generate observation control file needed for automatic operation of a pass. Manual intervention will be minimal for routine operations.

Customer's view of Operations - The nominal customer interface is via web using scheduling and mission parameter file. The operations staff will be available to support the customers in real time during emergencies and on 8X5 basis during normal operations. During a pass the customer will be able to look at the monitor information/data, and modify the mission parameter file, if necessary.

Maintenance Philosophy - The real-time operations will be managed by a few 24X7 real-time operators. The technical staff at RACs and at the DSN Array Central will work 8X5 to do maintenance, calibration, analysis, reporting and other logistic support work.

Current Status and Timeline - We are currently building a breadboard array of 3 antennas to determine cost and performance of antennas and electronics for the array. During 2006-07 we plan to build (1) an array for Robotic Lunar Exploration Program (RLEP) which is scheduled to launch its first mission in Oct 2008, and (2) an array of 12 12m antennas, to be operated in shadow mode to evaluate and refine the array design and operations concept. We plan to build 100 antenna arrays in 2008-10 at each of the three longitudes (USA, Australia and Europe), add 200 antennas at each longitude in 2011-12, and add another 100 antennas at each longitude, completing the 1200 antenna array, in 2013.